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Effects of preshipping management on measures of stress and performance of beef steers during feedlot receiving[1]

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ABSTRACT: Over 2 yr, a total of 96 steers (approximately 7 mo of age) were allocated to 1 of 4 weaning management strategies: 1) control: weaned on the day of shipping; 2) creep-fed: allowed free-choice access to concentrate before weaning and shipping; 3) preweaned: weaned and provided supplemental concentrate on pasture before shipping; and 4) early-weaned: weaned at 70 to 90 d of age and kept on pasture. On the day of shipping, steers were loaded together onto a commercial livestock trailer and transported 1,600 km over 24 h before being received into the feedlot. At the feedlot, steers were penned by treatment (4 pens/treatment) and provided access to free-choice hay and concentrate in separate feeding spaces. Samples of blood were collected on d 0, 1, 4, 8, 15, 22, and 29 relative to shipping. Steer performance was assessed over the receiving period, including DMI of hay and concentrate, ADG, and G:F. Predetermined contrasts included control vs. early-weaned, creep-fed vs. preweaned, and control vs. creep-fed and preweaned. Overall ADG was greater ($P < 0.01$) for early-weaned vs. control steers (1.39 vs. 0.88 kg). In wk 1, early-weaned steers consumed more concentrate and less hay compared with control steers ($P < 0.03$), and preweaned steers consumed more concentrate ($P < 0.01$) but a similar amount of hay ($P = 0.75$) compared with creep-fed steers. Average DMI was greater for preweaned compared with creep-fed steers (2.84 vs. 2.50% of BW; $P = 0.01$) and tended to be greater for early-weaned compared with control steers (2.76 vs. 2.50% of BW; $P = 0.06$). Feed efficiency of early-weaned steers was greater than that of control steers (G:F = 0.17 vs. 0.12; $P < 0.01$) but similar for preweaned compared with creep-fed steers ($P = 0.72$). Plasma ceruloplasmin concentrations were less ($P < 0.05$) in control vs. early-weaned steers on d 0, but increased sharply after shipping and were greater in control vs. early-weaned steers on d 15 and 22 ($P < 0.05$). Creep-fed steers also experienced greater ($P < 0.05$) plasma ceruloplasmin concentrations than preweaned steers on d 29. These data suggest that early-weaned steers have improved performance in the feedlot compared with steers weaned directly before transport and feedlot entry. Differences in preshipping management appear to significantly affect measures of the acute phase protein response in steers.

Key words: acute phase protein, preconditioning, steer, stress, transportation, weaning

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INTRODUCTION

Three of the most stressful events encountered by a feeder calf are weaning, transportation, and feedlot entry. These events lead to multiple physiological, nutritional, and immunological changes in the calf (Loerch and Fluharty, 1999). Although Florida is the leading state in the United States for the number of large cow-calf operations (>2,500 cows; USDA, National Agricultural Statistics Service, 2002), there is no commercial feedlot industry; therefore, nearly all market steers are shipped outside the state for further growing and finishing. Stressors associated with weaning and shipping are key factors affecting subsequent calf health and performance. Multiple research efforts have focused on management of these stressed calves and on systems that will decrease morbidity and improve performance (Duff and Galyean, 2007). Previous research efforts focused on early-weaning calves at 70 to 90 d of age have reported improved feedlot performance (Peterson et al., 1987; Myers et al., 1999; Arthington et al., 2005). This

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response appears to be related, at least in part, to reduced plasma concentrations of acute phase proteins, such as ceruloplasmin, haptoglobin, and fibrinogen, in early-weaned calves (Arthington et al., 2005). In addition to early weaning, other preweaning management options exist, such as weaning calves on the ranch for a period of time before transport (30 to 45 d) or creep feeding calves before weaning. Although results have been variable (Pritchard and Mendez, 1990), these systems may provide further value to both the producer and buyer (Dhuyvetter et al., 2005; King et al., 2006). The objective of the present study was to evaluate the effects of 4 preweaning management systems on plasma acute phase protein concentrations and the performance of weaned, transported steers during a 30-d feedlot receiving period.

MATERIALS AND METHODS

Animals, Experimental Design, and Sample and Data Collection

This study was conducted at the University of Florida, Range Cattle Research and Education Center (**RCREC**), Ona, and the USDA-ARS Subtropical Agricultural Research Station (**STARS**), Brooksville, FL. Animals were cared for by acceptable practices as outlined in the Guide for the Care and Use of Agricultural Animals in Agricultural Research and Teaching (FASS, 1999).

This study was conducted over 2 consecutive years (2004 and 2005) with 96 Angus-sired steer calves derived from multiparous Brahman × British cows (64 and 32 in yr 1 and 2, respectively). Steers were randomly allocated to 1 of 4 weaning treatments, which were imposed on all calves at the ranch of birth (RCREC) before transport to the receiving feedlot (STARS). Weaning treatments consisted of 1) early weaning, 2) creep feeding, 3) preweaning, or 4) control (24 steers/treatment; 16 and 8 for yr 1 and 2, respectively). Early-weaned steers were weaned in January at approximately 70 to 90 d of age and grazed on annual ryegrass (*Lolium multiflorum*) pastures during the winter months and perennial grass pastures during the summer months [bermudagrass (*Cynodon dactylon*) in yr 1 and a combination of bahiagrass (*Paspalum notatum*) and stargrass (*Cynodon* spp.) in yr 2]. Early-weaned steers were provided supplemental concentrate (1% BW; Table 1) daily from the time of weaning until shipping. Creep-fed steers were provided free-choice access to the same concentrate supplement (Table 1). Preweaned steers were separated from their dam before shipping and also provided access to the same concentrate supplement (Table 1). Creep feeding and preweaning were initiated 45 and 53 d before shipping in yr 1 and 2, respectively. All steers were provided free-choice access to a complete salt-based trace mineral supplement, which contained 12.0% Ca, 9.0% P, 9.0% Na, 0.30% Zn, 0.15% Cu, 0.05% Mn, 0.02% I, 0.005% Co, and 0.004% Se.

Table 1. Nutrient composition of concentrate and hay (DM basis)[1]

Item, %	Concentrate	Hay
CP	15.1	8.6
ADF	14.2	37.6
NDF	26.4	75.1
TDN[2]	78.3	53.2
Ca	0.63	0.44
P	0.63	0.22

[1]Concentrate consisted of ground corn (40%), wheat middlings (30%), cottonseed meal (12%), cottonseed hulls (10%), molasses (6.25%), calcium carbonate (1.25%), and vitamin-mineral premix (0.50%). Samples of concentrate and hay were collected daily beginning on d 1 and dried in a forced-air oven (50°C) and ground to pass a 1-mm screen. Samples were pooled within week. Values presented in the table represent the mean of 8 individually assayed subsamples (4/yr).

[2]TDN was calculated as described by Weiss et al. (1992).

On d 0 (early August), all steers were loaded together onto a commercial livestock trailer and driven within the state of FL for approximately 1,600 km before being delivered to the research feedlot at STARS. Steers remained on the trailer for 24 h before being unloaded (d 1). Before arrival, steers were randomly assigned within weaning treatment to 1 of 16 pens (4 and 2 steers/pen for yr 1 and 2, respectively). Assignment was achieved by stratifying steers from heaviest to lightest within treatment by using BW at d 0 and then randomly allotting steers to pens. In this manner, excessive variation in average BW among pens within a treatment was minimized. Steers remained in the feedlot for 29 d and were provided free-choice access to the same concentrate used for the preshipping treatments (Table 1). Steers were also provided free-choice access to long-stem bermudagrass hay and the same free-choice, salt-based trace mineral supplement provided before d 0 (described above). Daily intake of concentrate and hay were determined by subtracting the DM of the daily refusal from the DM of the daily offer of both hay and concentrate. Feed DM was achieved by drying daily samples in a forced-air oven at 55°C for 48 h. Daily samples of hay and concentrate were pooled by week and submitted to a commercial laboratory for nutrient analysis (Dairy One Laboratory, Ithaca, NY; Table 1).

Steer BW was determined before shipping (d 0), on arrival (d 1), and at the conclusion of the study (d 29; following a 16-h removal from concentrate and hay). Individual steer ADG during the receiving period was determined by the difference between the final shrunk BW and initial arrival BW (d 1). Transport BW shrink was measured as the percentage change from the BW before shipping (d 0) and the BW at arrival (d 1). For acute phase protein analyses, blood samples from each steer were collected from the jugular vein into heparin-coated evacuated tubes (Vacutainer, Becton Dickinson Inc., Franklin Lakes, NJ) at d 0, 1, 4, 8, 15, 22, and 29. Tubes were immediately placed on ice until transfer to

4°C, at which they were stored for 24 h before centrifugation at 2,000 × g for 20 min. Samples were stored frozen at −20°C until later analysis.

Assessment of Calf Temperament

The impact of weaning management treatment on measures of steer disposition was assessed on d 0 before loading steers onto the transport trailer. Measures included 3 methods of temperament assessment, including chute exit velocity and a subjective temperament score assigned to each calf in the chute (chute score) and in a pen (pen score). Exit velocity was achieved by determining the speed of the calf exiting the squeeze chute by measuring rate of travel over a 1.6-m distance with an infrared sensor (FarmTek Inc., North Wylie, TX). Chute score was assessed by a single technician based on a 5-point scale (adapted from Voisinet et al., 1997), where 1 = calm, no movement, 2 = restless shifting, 3 = constant shifting with occasional shaking of the chute, 4 = continuous movement and shaking of the chute, and 5 = violent and continuous struggling. For pen score assessment, steers exited the chute and entered a pen (10 × 15 m) containing a single technician and no other cattle. Once the steer entered the pen and noticed the technician standing inside the pen near the perimeter fence, the technician moved 3 steps directly toward the steer and assessed his response on a 5-point scale, where 1 = unalarmed and unexcited, walking slowly away from the technician, 2 = slightly alarmed, moving moderately quickly away from the technician, 3 = moderately alarmed and excited, moving away from the technician quickly, 4 = very alarmed and excited by the presence of the technician, moving very quickly and with head held high, or 5 = very excited and aggressive toward the technician in a manner that requires evasive action to avoid contact between the technician and steer.

Acute Phase Protein Analysis

Plasma concentrations of haptoglobin and ceruloplasmin were assayed. Plasma haptoglobin concentrations were determined in duplicate samples by measuring haptoglobin-hemoglobin complexing by the estimation of differences in peroxidase activity (Makimura and Suzuki, 1982). Results are expressed as arbitrary units resulting from the absorption reading at 450 nm × 100. For samples with an absorption reading of ≤0.010, the intraassay coefficient of variation (**CV**) of duplicate samples was controlled to values of ≤20%, and for samples with an absorption reading of ≥0.010, the intraassay CV of duplicate samples was controlled to values of ≤10%. Plasma ceruloplasmin oxidase activity was measured in duplicate samples by using the colorimetric procedures described by Demetriou et al. (1974). The intraassay CV of duplicate samples was controlled to values of ≤10%. Ceruloplasmin concentrations were expressed as mg/dL as described by King (1965). Interassay variation of both acute phase protein assays were controlled by CV limits of ≤10% as a result of a control sample analyzed in duplicate within each individual assay run. When the interassay CV exceeded 10%, all samples contained in the individual run with the control sample exceeding the average by the most were reanalyzed. This step was repeated until the results of standard pools for all runs resulted in a CV of ≤10%.

Statistical Analysis

All data were analyzed by ANOVA for a completely randomized design by using the MIXED procedure (SAS Inst. Inc., Cary, NC). Before leaving from the ranch of origin (RCREC), calves were maintained in single groups within treatment designation; therefore, treatments were replicated once (2-yr study). For analysis of preshipping ADG, temperament, and BW before shipping (d 0) and on arrival in the feedlot (d 1), the model statement contained the effect of treatment, and year(treatment) was the random variable. Pen was the experimental unit for all measurements during the feedlot receiving period, and year(pen × treatment) was the random variable. For analyses involving measurements collected over time (hay and concentrate DMI and acute phase protein concentrations), a repeated measures analysis was conducted, with the model statement containing the effects of treatment, time, and their interaction. For analyses involving shrink, ADG, overall DMI, and G:F, the model statement contained the effect of treatment. Treatment comparisons were made by using single-df orthogonal contrasts. The 3 treatment comparisons were 1) control vs. early-weaned, 2) creep-fed vs. preweaned, and 3) control vs. creep-fed and preweaned.

RESULTS AND DISCUSSION

Steer Performance

Preweaning and creep feeding began at the same time, which was 45 and 52 d before shipping in yr 1 and 2, respectively. Steer BW and ADG before feedlot entry are provided in Table 2. Before shipping and while on pasture, average voluntary concentrate intake for creep-fed steers was 2.6 kg/d. Tarr et al. (1994) also reported annual variability in creep-feed intake, with an average daily intake of creep feed similar to those of the current study. The difference in BW gain of creep-fed calves, beyond that realized by control calves, was 0.05 kg/d. Efficiency of this added BW gain was poor (G:F = 0.02) and was less than the values reported by Tarr et al. (1994). This difference may have been the result of the limited time of creep feeding in the current study (45 and 53 d in yr 1 and 2, respectively). Other researchers have shown that creep-feed intake and BW gain increase with advancing days of creep feeding (Faulkner et al., 1994; Tarr et al., 1994). Preweaned steers were offered the same concentrate supplement

Table 2. Effects of weaning management treatment on steer performance before shipping[1]

Item	Control	Creep-fed	Preweaned
		kg	
Initial BW	248	251	245
Final BW	276	285	273
ADG[2]	0.60	0.65	0.59

[1]Steers were maintained in a single group within treatment before shipping; therefore, treatment replication occurred within year over the 2-yr study. Values are least squares means (pooled SEM = 5.7, 6.4, and 0.09 for initial BW, final BW, and ADG, respectively). Values do not differ (PDIFF; $P > 0.66$, 0.49, and 0.46 for initial BW, final BW, and ADG, respectively). Average concentrate intake of creep-fed steers was 3.3 and 1.8 kg/d for yr 1 and 2, respectively. Preweaned steers were offered the same concentrate supplement, and average intake was 4.0 and 4.1 kg/d in yr 1 and 2, respectively. Early-weaned steers are not presented in the table. Early-weaned steers were separated from their dams at approximately 80 d of age and grazed on winter and summer pastures with concentrate supplement at 1% of BW daily.

[2]Calculated over 45 and 53 d in yr 1 and 2, respectively.

before shipping, but consumption was limited so as not to exceed 4.5 kg/steer daily. Average concentrate intake of preweaned steers was 4.1 kg/d.

On the day of shipping (d 0), there were no significant differences in BW among the 4 weaning treatments (Table 3). We have previously observed annual variability in BW of early- vs. normally weaned calves at the time of shipping (Arthington and Kalmbacher, 2003). In that study and the current study, calves are weaned at the ranch of birth at 70 to 90 d of age and grazed on winter annual and summer perennial pastures. Daily concentrate supplementation is provided at 1.0% of BW. Before the time that normally weaned calves are separated from their dam, performance differences vary annually among early- and normally weaned calves, which are likely the result of the environmental impacts on available forage quality and quantity (Vendramini et al., 2006).

Steer ADG during the 29-d receiving period was greater ($P \leq 0.01$) for early-weaned steers compared with control steers (Table 3). Improved ADG of early-weaned vs. control steers has been shown previously. In a study imposing similar transportation methods (Arthington et al., 2005), early-weaned calves experienced a 54% greater ADG than their normally weaned contemporaries. One explanation for the greater BW gain of early-weaned steers may be attributed to differences in diet selection compared with control steers. Early-weaned steers had a greater DMI of concentrate and a lesser DMI of hay compared with control steers during the first week in the feedlot (Table 4; $P \leq 0.03$). Increased dietary energy intake has been shown to improve BW gain of calves during the initial feedlot receiving period (Lofgreen et al., 1980). After the first week, there were no further DMI differences between these weaning treatments; however, average DMI for the 4-wk receiving period tended to be greater ($P = 0.06$) for early-weaned steers compared with control steers (Table 3).

There were no differences in ADG among preweaned and creep-fed steers, although the mean ADG of these treatments was greater than for control steers (1.11 vs. 0.88 kg/d; $P = 0.02$; Table 3). Preweaned steers had a greater ($P \leq 0.03$) DMI of concentrate, but not hay, compared with creep-fed steers during the first 2 wk in the feedlot (Table 4). Similarly, the average DMI of preweaned and creep-fed calves was numerically greater, albeit nonsignificant ($P = 0.14$), compared with control calves for the 4-wk receiving period (Table 3), which likely contributed to the greater ADG for creep-fed and preweaned calves compared with control calves (Table 3). These results indicate that the preshipping management of feeder calves affects voluntary DMI of concentrate vs. hay when both are offered separately. This management procedure is a common practice among feedlots receiving stressed calves, where calves may be offered free-choice access to hay in addition to

Table 3. Effect of weaning management treatment on steer feedlot performance over a 29-d receiving period[1]

Item	Control	Creep-fed	Early-weaned	Preweaned	Contrast[2] 1	2	3	SEM
BW								
Day 0	276	285	276	273	0.99	0.44	0.81	10.4
Day 1	253	263	250	247	0.81	0.24	0.87	8.6
Day 29	288	301	299	289	0.08	0.05	0.20	4.1
Shrink,[3] %	8.11	7.53	9.25	9.50	0.41	0.19	0.73	0.89
ADG,[4] kg	0.88	1.05	1.39	1.16	<0.01	0.32	0.02	0.08
Average DMI,[5] % of BW	2.50	2.50	2.76	2.84	0.06	0.01	0.14	0.09
G:F[5]	0.12	0.13	0.17	0.14	<0.01	0.72	0.12	0.008

[1]Calf BW was determined before shipping (d 0), upon arrival (d 1), and at the conclusion of the study (d 29) following a 16 h removal from concentrate and hay. Values are least squares means.

[2]Contrasts: 1 = early-weaned vs. control; 2 = preweaned vs. creep-fed; 3 = control vs. preweaned and creep-fed.

[3]Transport BW shrink was calculated as the percentage change from the BW before shipping (d 0) and the BW at arrival (d 1).

[4]Calf ADG during the receiving period was determined by the difference between the final shrunk BW (d 29) and initial arrival BW (d 1).

[5]Daily intakes of concentrate and hay were determined by subtracting the DM of the daily refusal from the DM of the daily offer of both hay and concentrate. Feed DM was achieved by drying daily samples in a forced-air oven at 55°C for 48 h. Feed efficiency (G:F) was calculated for by dividing the total DM consumed from d 1 to 29 into the total BW gain achieved over this time period.

Table 4. Effect of weaning management treatment on steer voluntary concentrate and hay DMI over a 29-d receiving period[1]

Item	Control	Creep-fed	Early-weaned	Preweaned	Contrast[2] 1	2	3	SEM
	DMI, % of BW							
Concentrate								
Wk 1	1.30	1.62	2.17	2.24	<0.01	<0.01	<0.01	0.12
Wk 2	2.04	2.13	2.31	2.51	0.12	0.03	0.06	0.12
Wk 3	2.28	2.26	2.40	2.38	0.32	0.32	0.74	0.08
Wk 4	2.23	2.19	2.35	2.48	0.27	0.01	0.28	0.08
Hay								
Wk 1	0.66	0.42	0.42	0.38	0.03	0.75	0.01	0.07
Wk 2	0.57	0.47	0.45	0.43	0.33	0.75	0.29	0.09
Wk 3	0.47	0.45	0.47	0.48	0.97	0.78	0.98	0.08
Wk 4	0.46	0.46	0.48	0.48	0.88	0.88	0.94	0.09
Total								
Wk 1	1.94	2.04	2.58	2.62	<0.01	<0.01	<0.01	0.10
Wk 2	2.61	2.60	2.76	2.95	0.11	0.37	0.37	0.15
Wk 3	2.75	2.71	2.87	2.86	0.32	0.82	0.82	0.11
Wk 4	2.69	2.65	2.83	2.95	0.30	0.34	0.34	0.09

[1]Daily intake of concentrate and hay were determined by subtracting the DM of the daily refusal from the DM of the daily offer of both hay and concentrate. Feed DM was achieved by drying daily samples in a forced-air oven at 55°C for 48 h. Values are least squares means.

[2]Contrasts: 1 = early-weaned vs. control; 2 = preweaned vs. creep-fed; 3 = control vs. preweaned and creep-fed.

a complete mixed starter ration. In this study, calves that had been previously exposed to concentrate supplement had a greater percentage of DMI of concentrate vs. hay during the first week in the feedlot (66.4 vs. 79.0, 84.0, and 85.4% of total DMI as concentrate for control, creep-fed, early-weaned, and preweaned calves, respectively; $P < 0.05$ for both early-weaned vs. control steers and the average of preweaned and creep-fed steers vs. control steers; SEM = 3.06).

Calculated over the 29-d feedlot receiving period, early-weaned calves had a 42% improvement in G:F compared with control calves (Table 3). Improved feedlot performance of early-weaned calves has been reported previously (Myers et al., 1999; Arthington et al., 2005). Feed efficiency did not differ ($P = 0.72$) among creep-fed and preweaned calves; however, the efficiency of control calves was numerically inferior to the average efficiency of creep-fed and preweaned calves ($P = 0.12$; Table 3).

Acute Phase Protein Concentrations and Steer Temperament

Although there was a treatment × day interaction for plasma haptoglobin concentrations ($P < 0.02$), there were no significant single-df treatment contrasts within sampling days (data not shown). The interaction is a result of the magnitude and time of increase in plasma haptoglobin concentrations after shipping vs. individual treatment differences within sampling days. Pooled across all treatments, haptoglobin concentrations increased by 160% from d 0 to 1 and returned to baseline values by d 8. Preweaned calves tended ($P = 0.08$) to have a lesser increase in plasma haptoglobin compared with creep-fed calves. Although numerically greater than control calves, early-weaned calves experienced a similar increase in plasma haptoglobin concentrations from d 0 to 1 (2.15, 2.63, 1.49, and 1.50 absorption at 450 nm for control, creep-fed, early-weaned, and preweaned calves, respectively).

There was a treatment × day interaction ($P < 0.01$) for plasma ceruloplasmin concentrations. Ceruloplasmin concentrations were initially less in control steers compared with early-weaned steers ($P < 0.05$; Figure 1). After transport, ceruloplasmin concentrations increased sharply in both groups and were greater ($P < 0.05$) in control steers compared with early-weaned steers on d 15 and 22, and tended to be greater ($P < 0.10$) on d 8 and 29 (Figure 1). Ceruloplasmin concentrations were generally greater in creep-fed vs. preweaned steers (Figure 1), with differences ($P < 0.05$) observed on d 29 (Figure 1).

Activation of the acute phase protein reaction is a normal immunological reaction to stress stimuli, such as vaccination, disease exposure, weaning, and social order disruption. The response is characterized by increased concentrations of circulating proinflammatory cytokines (Klasing and Korver, 1997), which affect nutrient metabolism and animal growth (Johnson, 1997). Research has shown that early-weaned calves have a lessened acute phase protein response after transport and feedlot entry compared with control calves weaned on the day of transport (Arthington et al., 2005). The magnitude of this acute phase response is negatively correlated to calf ADG after transport (Arthington et al., 2005; Qiu et al., 2007) and positively associated with the incidence of morbidity and subsequent requirement for antimicrobial treatment (Carter et al., 2002). The first few days after feedlot entry are critical to the subsequent health and productivity of the

Table 5. Effect of weaning management treatment on measures of steer temperament before leaving the ranch of origin (d 0)

					Contrast[2]			
Item[1]	Control	Creep-fed	Early-weaned	Preweaned	1	2	3	SEM
Exit velocity, m/s	2.22	2.50	2.82	2.37	0.29	0.81	0.65	0.35
Chute score	1.88	2.07	1.61	2.66	0.50	0.18	0.21	0.26
Pen score	2.22	2.58	2.00	2.39	0.38	0.43	0.23	0.16

[1]Exit velocity from the squeeze chute as the rate of travel over a 1.6-m distance. Chute score was assessed on a 5-point scale: 1 = calm, and 5 = violent and continuous struggling. Pen score was assessed immediately after release from the chute on a 5-point scale: 1 = unalarmed and unexcited, walking slowly away from the technician, and 5) very excited and aggressive toward the technician in a manner that requires evasive action to avoid contact between the technician and calf. Values are least squares means.

[2]Contrasts: 1 = early-weaned vs. control; 2 = preweaned vs. creep-fed; 3 = control vs. preweaned and creep-fed.

beef calf. The acute phase protein response following transport has been characterized in this and 2 other studies (Arthington et al., 2003, 2005). In each of these efforts, no incidence of morbidity was realized, even though the acute phase protein reaction was evident in each study. Therefore, it is apparent that overtly healthy calves still undergo the acute phase reaction and produce acute phase proteins as a result of normal management procedures such as weaning and transportation. The magnitude of this response may be a key indicator of subsequent productivity in the feedlot, especially during the initial receiving period (Arthington et al., 2005; Qiu et al., 2007). In more typical production situations, feedlot managers experience some level of morbidity in newly received feeder calves. The magnitude of the acute phase reaction is greater in these cases of clinical morbidity compared with calves that did not become morbid (Carter et al., 2002). Defined calf preconditioning programs (Roeber et al., 2001) and creep feeding (Fluharty and Loerch, 1996) have both been shown to reduce the incidence of morbidity significantly in newly received feeder calves. If the calves in the current study had undergone a greater amount of stress or immunological challenge, we likely would have realized greater differences in the acute phase protein response and subsequent productivity of the preweaned and creep-fed calves compared with control calves.

No treatment effects ($P > 0.10$) were observed for the selected measures of steer temperament in this study (Table 5). Other researchers have reported that feeder calves with calmer temperaments have improved ADG compared with cattle with excitable temperaments (Voisinet et al., 1997). In that study, researchers noted that cattle with Brahman influence exhibited a more excitable temperament compared with those with no Brahman influence (Voisinet et al., 1997). It is reasonable to anticipate behavioral differences because of the management treatments imposed in the current study, especially given the Brahman influence of the calves; however, no differences were observed. The lack of statistical significance is attributed to the lack of experimental units contributing to this analysis, because it involved replication only over the 2 yr of the study.

Economic Considerations

In the current study, the intake of creep feed was not substantial (2.6 kg/d). At these rates, feed costs represented an average of $37 per calf annually (average of 49 d consuming 2.6 kg/d at $0.29/kg). Compared with control calves, the added gain resulting from creep feed-

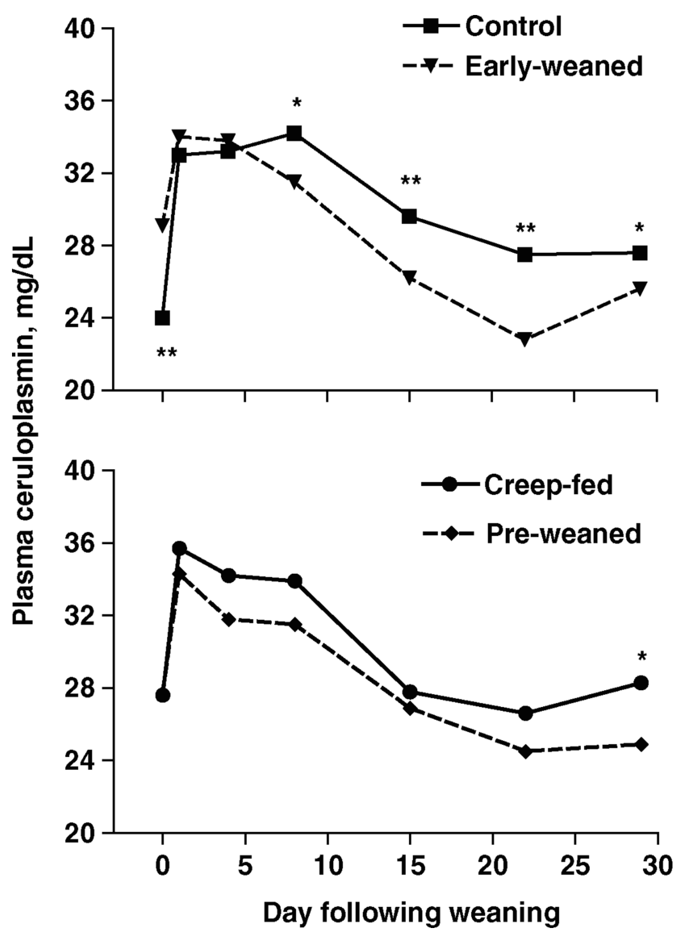

Figure 1. Effect of weaning management on plasma ceruloplasmin concentrations during a 29-d feedlot receiving period. Greatest pooled SEM = 1.24. Treatment × day, $P < 0.01$. An asterisk (*) and a double asterisk (**) indicate that single-df contrasts differ at $P < 0.05$ and 0.10, respectively.

ing was only 0.05 kg/d. This is a poor result and could potentially be lessened if the creep-feeding process had been extended for a longer period of time.

Although few, if any, value-added marketing programs target creep feeding as a management prerequisite, a period of on-ranch weaning before shipping (preweaning) is a commonly prescribed calf preconditioning procedure. Although poorly presented in the scientific literature, preweaning is believed to prepare the calf for the stressors associated with transport and feedlot entry, thereby decreasing the stress-related incidences of morbidity. Cattle derived from a defined preconditioning program have been shown to have fewer incidences of morbidity and greater ADG during the first 2 mo in the feedlot (Roeber et al., 2001). In the current study, preweaned and creep-fed calves had a greater ($P = 0.02$) ADG compared with control calves during a 29-d feedlot receiving period. Indeed, inherent variation found among years and locations is a major factor affecting the value of preconditioning programs involving preweaning management systems (Pritchard and Mendez, 1990). This lack of regularity among performance responses is a major consideration when deciding whether to prewean beef calves on the ranch before shipping. Risks associated with preweaning must also be weighed against any potential advantages associated with market premiums paid for the practice. In our study, the average feed inputs associated with preweaning before shipping were $58 per calf. This estimate does not include the costs associated with the risk of calf loss through death or injury after weaning, nor does it include costs associated with labor or miscellaneous expenses such as fencing and feeding equipment. To account for expenses associated with the purchase of feed, steer calves in the current study (average BW at d 0 = 273 kg) would need to receive a premium of more than $9.50/cwt (1 cwt = 45.45 kg). A comparison of calves with similar vaccination management revealed an average premium of $4.19 per cwt for calves that were preweaned for at least 45 d before shipping compared with calves shipped at the time of weaning (King et al., 2006). That study used 2,777 lot loads (approximately 22,600 kg of net weight/lot load) of cattle, representing more than 326,000 feeder calves. Under the feed cost conditions realized in the current study, their results suggest that cattle buyers are not currently willing to pay a premium for preweaned calves sufficient to account for the costs associated with the purchase of feed required for the management practice. Fifteen years before the current study was conducted, Peterson et al. (1989) reported an economic evaluation of the value of preconditioned beef calves to the cow-calf producer. In that study, a similar gap was observed between the costs associated with calf preconditioning and the price-premium received for the practice. Nevertheless, changes in the industry may be occurring because the average value of 45-d preweaned calves has increased steadily over the past 11 yr in lot-load feeder calves marketed through a livestock videotape auction service (King et al., 2006). Other factors should also be considered that may improve the economic viability of weaning calves on the ranch before shipping, including 1) regional differences in feed costs, 2) efficiency of gain and change in calf value from the time of weaning to shipping, and 3) opportunities for smaller collaborating producers to achieve truckload groups of weaned feeder calves. Additional industry evaluation is warranted to further determine the value of preshipping management systems to both the seller and buyer of the feeder calf.

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